INNOVATIONS IN LEARNING AND TEACHING INTERACTIONS BETWEEN BA (HONS) PRODUCT DESIGN AND BSC (HONS) PRODUCT DESIGN ENGINEERING STUDENTS ON DESIGN PROJECTS

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Abstract

This paper examines methodologies and strategies used to motivate BA (Hons) Product Design (BAs) and BSc (Hons) Product Design Engineering students (BScs) to successfully work in pairs to design innovative and unusual kitchen gadgets. This was a live project with an industrial partner, in this instance design-led leading kitchen gadget company 'Joseph Joseph' (JJ).

It details motivational techniques championed by the tutor(s) to enhance the product outcomes, enthuse and benefit students including the pioneering pairing of BAs and BScs within the Product Design Engineering Department of Middlesex University for the very first time.

Techniques such as enhanced visualisation through meditation, skill sharing, iterative prototyping, body-storming and presentation skills are examined to ascertain how the project received very high satisfaction and engagement rates from students as well as fulfilling the client brief to a very high standard. A detailed feedback questionnaire was filled in by each student and acts as statistical validation of method and satisfaction rate. Several outcomes from this project were of a high enough standard to be taken to the second stage of consideration for manufacture by the top stainless steel manufacturer in Germany.

The paper concludes that creativity is greatly enhanced by skill sharing, many quick activities in the initial ideas stage and a long period of functionality development in the workshops.

This is done before final designs can be more fully worked out using the best of BA/BSc knowledge and skills.

Keywords: Innovation, creativity, Product Design Engineering, shared learning, technology, motivation

1 INTRODUCTION

'Product design is the convergence for engineering and design thinking and practices. Until recently, product design has been taught either as component of mechanical engineering or as a subject within design schools but increasingly there is global recognition of the need for greater synergies between industrial design and engineering training (de Vere et al 2010)

'In the current climate, engineers must be flexible, creative and solution-focussed with a strong understanding of human-centred design and an ability to work in multi-disciplinary contexts (Grasso and Martinelli 2007 cited in de Vere et al 2010)

There is empirical evidence of current best design practice consisting of harnessing the best of engineering with the best of design/arts rather than lone discipline designers working in isolation, for the purpose of making designers 'integralists' (Eekels 1987 cited in de Vere et al 2010). Design engineering is becoming a much sought after, employable skill (Cox Review of Creativity in Business 2005, Gower Review of intellectual Property 2006, Design Skills Advisory Panel 2007 on behalf of the Design Council, all cited in Prior et al, 2008) and attainment of this skill gives much greater chances of employment (Prior et al 2008, Cross 2006 cited in de Vere et al 2010).

An experimental research project was undertaken to put BA (Hons) Product Design (BA) and BSc Product Design Engineering (BSc) students into pairs (BA/BSc) on Design Projects, so that students would become more synergistic designers/design thinkers through the cross fertilization of knowledge via working with their opposite discipline.

This was a vehicle to test out a variety of techniques, many informed by the practice and process of the authors in their own projects over many years including techniques imbibed on creativity courses, through teaching experience, experimentation and meditation. The methodologies used were designed to stimulate creativity, engagement, lateral design thinking, technical know-how, skill sharing and high-level project outcomes, and were taught by tutors from BA and BSc backgrounds respectively in association with industrial partners, who sponsored the 'live' projects.

A detailed questionnaire about the course was completed by each student to reflect their individual experience of working in pairs (SQ) and acts as validation of method and satisfaction rates in addition to the standard University feedback forms that assessed statistical satisfaction rates with the module (UMSQs).

Client satisfaction rates and outcomes were extremely high and are examined in comparison with the previous year's results for BA and BSc students working alone within their separate disciplines. It supports the conclusion that whilst there are ongoing adjustments to be made, this method of teaching has an important place and has been adopted as standard by us as a consequence. The paper concludes that creativity and cross disciplinary knowledge is greatly enhanced by skill-sharing, many quick activities in the initial ideas stage and a long period of functionality development in the workshops before final prototypes are made, to build on the *'natural aptitude for design thinking, which the right development and experiences can unlock'* and encourage *'integrative thinking'* (Brown 2008).

2 METHODOLOGY

There were two design projects undertaken over an eleven week period with a mixed student cohort of twenty-two students of equal numbers from each discipline (BA and BSc) for three and eight weeks respectively. The students came from completely mixed backgrounds in terms of age and ethnicity and were aged between 19 and 28. For each project, an industrial partner sponsored the project and came in periodically to give feedback, advice and industry expertise. The first project, seen as a 'warm up', was worth 25% of the marks and the second, main project, 75%. Students were continually assessed at junction points in the projects to give them maximum feedback at all stages.

We discussed whether to put students into pairs or whether to allow them to self-select for Project 1, and as they did not really know each others' work, being on different courses, we allowed them to self-select BA/BSc pairs. We also believed that they would adjust to the process more easily if they felt that they had had some choice about who their partner was. We made each pair swap partner (still BA/BSc) for Project 2 so that they would face a fresh set of challenges but still allowed them to self-select partners, the rationale being that they would have recognised through class feedback in Project 1 which students were at their level of competence for the second project and be able to choose wisely. Below are detailed the range of activities used, including sketching and prototyping methodologies, presentation skills and body storming for the purposes of new product development.

Between sessions for both projects, direction and encouragement were posted on an e-Learning space. Students could comment or write on the whiteboard if they had any queries, so that the whole group could comment and benefit.

2.1 Project 1

2.1.1 Overview

This brief was concerned with finding new and innovative packaging and hanging solutions for the retail industry for client 'B'. Students had had a long break since the end of their first academic year and this project was intended to be a short, sharp and effective introductory project before the main project. The tutors wanted to demonstrate to students the value of activity related exercises for creativity generation in a short space of time rather than staring at blank pieces of paper with 'designer's block'.

Students brainstormed the shopping experience in groups of six on large sheets of paper with marker pens. Post-it notes were used to categorise different aspects of this experience and collated into categories such as Shopping Requirements, User Experience and Design Requirements. A whole raft of materials were bought for experimentation with prototypes including corrugated card, metal mesh, wire, Sellotape®, masking tape, coloured sticky tapes, cardboard rolls, scalpels, stretchy fabrics, model-making high density foam, Letraset®, coloured dots, ply, Perspex® and hot glue, and a

freelance designer for the commissioning company joined us once a week for the three week project to give the company perspective, design input and feedback.

2.1.2 Creativity Generation

To activate creativity, students were given an hour to come up with no less than 10 'sketch' models of potential hanging ideas that did not need to be to scale. The instructions were given to 'just do it', not to think too hard, just play and allow the fun of the process to suggest possible outcomes (see Fig.1). This strategy came from a creativity course led by Dutch designer Maarten Baas at Boisbuchet (run by the Vitra Museum), who demonstrated how quickly ideas can be generated in a short space of time with card and tape. Meditation techniques and allowing the creative process to naturally happen by being 'in the moment' were also contributory factors both from written sources and personal experience (Osho 1999, Chopra 2003, Chopra 1989, Edwards 1989). From the outcomes of this experiment, after class review, the best idea was picked and another ten ideas extrapolated using the same methods for another hour.

Fig.1 Rapid ideas generation and engagement and tutorial input

2.1.3 Customer observation to inform further design thinking

Students had to subsequently spend two hours in the specified store doing customer observation, to see how customers shop, queue, how clothes are carried from rails to check-outs and to body-storm the process, that is, perform the same tasks, see how difficult it was to go from rail to changing room and cashier and bring back their observations and insights through verbal and photographic evidence. Time lines were created showing the customer *'touch-points'* (Lusch and Vargo 2006), that is, the opportunities for store and customer to interact with the hanging solution during the shopping experience – from manufacture to in-store, to recyling at the end of the product life-cycle.

They had to brain-storm with the results, making rough models as iterative prototypes, sketching and then going back to model making to develop their ideas in a progressive way. The models were once again sketch models, but this time informed by experience and not only instinctive insights.

'Sketching is an activity that is not only integral to the design process, but is closely related to developing a creative process as it allows 'the reflective conversation with the situation' (Schön and Wiggins 1992). Goel (1995) goes further with the 'dialectics of sketching' in which he describes the analogical reasoning and reinterpretation of the sketch that provokes creativity' (de Vere et al 2010)

2.1.4 Tutorial input and assessment

All tutors were very hands on during the creativity generation process, not 'lecturing' as such but working as fellow learners and prompters alongside the students.

The students were shown how to tailor presentation boards to a 'house-style' and how to produce mood boards and brand identity presentation sheets. They received intense feedback during the project from all tutors when they subsequently designed their own boards.

There were two assessment points and the client came in for the final session to give feedback and choose a prize-winning team. The four marking criteria for were the thoroughness of the research, the quality of the idea, the iterative process undertaken, and the final solution based on the incorporation of the former points in a logical way to demonstrate 'deep' rather than 'surface' design thinking and learning (Marton and Säljö 1976, Marton et al 1984 cited in Webb 1997).

The iterative process allowed the lateral jump from the sketch models to the final prototypes quite easily and the results exceeded the expectations of the students, staff and clients alike.

2.2 Project 2

2.2.1 Overview

Project 2 was concerned with designing innovative and unusual kitchen gadgets with a design-led, leading kitchen gadget company, Joseph Joseph (JJ). The brief was deliberately kept *'open-ended, exploratory'* (Lee 2009) but with *'clearly defined outcomes that allow multiple solution pathways'* (Okundan and Zappe 2006) in order to allow for the most unusual and open-ended results. The brief was to *'Peel, slice, chop, juice, grate. Take one of the above and design a new kitchen tool to perform its function in an original and effective way.'* (brief from JJ).

The strategy for this project was to front end a lot of time for research and particularly not to narrow down ideas too soon, allowing six weeks out of eight for iterative protoyping and allocating no marks at the second assessment presentation point for 'finished ideas' but rather for the all important 'process'. They had to *'be prepared to rethink'* (Brown 2008). The students were instructed to ignore the visual considerations of the product and concentrate on having fun working out its functionality until Week 7 out of eight on the project.

2.2.2 Research and finding market gaps in the kitchen gadget arena

Students had two weeks in which to analyse the market-place and competitive kitchenware products, analyse possible product features and technologies that could be employed, produce a mood board with brand typology and customer profiling and propose four different ideas in the form of text, sketches and images so the client could choose one for further development. Extensive feedback was given on the relevance of the idea and emphasis put on the idea being an 'idea space' that must develop and change, not a concrete idea in terms of form or function.

2.2.3 Creativity generation through meditation

It was expected that students would incorporate techniques from Project 1 in terms of design thinking, but the learning had not been fully integrated, so first ideas were not as expected and we had to stimulate creativity generation again in order to move the projects forward. Students were given an hour's creativity training through working with their opposite hand to draw their normal writing hand, which is an old technique by Betty Edwards (Edwards 1989) but still works extremely effectively. Once in Right Brain mode (Edwards 1989), they were instructed to close their eyes, allow random ideas to form and serendipitous connections to be made from the deep point of creativity within themselves where every type of associaton and connection is possible (personal experience, Chopra 1989, Chopra 2003) and the mind does not block the creative process with linear thinking:

'*an important minority of pioneering design theorists has implied that the most valuable part of the design process is that which occurs inside the designer's head and partly out of reach of his conscious control'* (Jones 1992 cited in Hsiao and Chou 2004).

'The design process is best described metaphorically as a system of spaces rather than a predefined series of orderly steps.' (Brown 2008)

With closed eyes and no judgment, they had to sketch the first ten ideas that came to mind on paper, however roughly and avoid talking, which makes the mind jump back to logical Left Brain mode (Edwards 1989). This was the catalyst to kick-start the creativity process once more.

2.2.4 Developmental prototyping

Once one idea was chosen from the four proposals, student pairs worked on the mechanism with a combination of rapid sketch ideas generation, using overlays of layout paper to improve their ideas and communicate their ideas to each other, and combine this with model-making. The iterative model-making and experience prototyping along with mind-mapping and the development of rigs meant that students spent almost all their time in the workshops 'playing', rationalising their play and improving time and again until they came up with a mechanism that would work for their chosen area from the brief and be unusual and innovative.

Experimentation took place in the workshops where harder materials like gelutong, MDF, wire and Milliput® were used as well as in the studio using similar materials to Project 1. Students had to produce detailed development sketches of the selected concept for assessment, and demonstrate evidence of user research and task analysis - how the product is held ergonomically, shown step by step photographically, to chart the process and highlight any shortfalls. Their prototypes were tested on other students, on each other and on consumers and some students also carried out further market

research independently. Students study Human Factors alongside Design Projects as a separate module, so they could cross-integrate this knowledge too.

How the products were held and functioned ergononomically had the highest priority and parts of blades from other gadgets were incorporated or made in the workshops to demonstrate the idea, for example razor blades and wires for cutting, grating meshes and whisk heads for pumping actions. The amount of pressure and effort needed for ergonomic use of the tools was examined in detail, and iterative improvements made time and again.

For the last two weeks, students were able to make their final models, which had to be working prototypes, many using Rapid Prototyping (RP) for fabrication at this stage, although others engineered their work using Milliput® and turned nylon as well as incorporating moving parts such as springs, blades and other mechansims from other gadgets. Some made their own blades for final prototypes in the workshops.

2.2.5 Tutorial and client input

In a module running alongside the Design Projects in Advanced CAD, instructions were given on snap fits and parts enclosures and CAD rendering to inform the process.

Presentation boards included General Arrangement drawings and included CAD renderings of the finished product including material choices, featuring perspective views from all angles plus an exploded view. CAD animations were not assessment requirements, but some pairs nevertheless produced them.

The final prototypes had to show Design for Manufacture and engineering shut lines, but did not need to show material choices, only form and function.

Class tutorials were held every week to peer group learn from other students and cross-fertilize good practice from stronger pairs to weaker pairs. In addition, extra tuition in In-Design and Photoshop was given to help improve board layout, close-ups of parts and how to clearly tag important parts of the gadget to enable the client to understand the concepts in detail. 1:1 tutorials were held in the last two weeks with each pair and both tutors.

2.2.6 Assessment

The client attended the first assessment point to help the students select the product to take forward from their four ideas. He was unable to attend the second assessment point, however detailed feedback was given remotely about the mechanisms, as well as detailed tutorial feedback from the tutors. He attended the final assessment point to give feedback about market potential and choose a winner(s).

The final marking criteria included evidence of innovation, evidence of concept development from direct observation of a market gap/need, the appropriateness of the solution to the Brand as a design-led, user-centred solution, quality of visual presentation, quality of verbal presentation and evidence of working rigs and finished Product Prototypes. This aimed to cover all aspects of converting the student pairs into professionals when presenting to a client and mirrored the real life situation they would face on employment in design studios upon completion of the course.

A prize-winning team were picked with a cash incentive and the opportunity for a placement within the company should be design be taken to production, along with a royalty deal.

3 RESULTS

3.1 Results Project 1

The quick creativity exercises in Project 1 yielded surprisingly innovative results, as did the touch-points exercise, which highlighted a number of considerations that had previously been overlooked.

The students were totally engaged very quickly with the immediacy of the process of ‘sketch’ models and brainstorming and came up with crazy ‘off the wall’ ideas that were great starting points. No ideas were discarded at the early stages. The BSc students were able to input a great deal to the BAs about gadgetry and know-how about how things work and the BAs were able to teach the BScs about aesthetics and the humanistic side of design as well as help them with board presentation, which they had learnt in their previous BA modules.

At first, students did not understand the concept of working together and some would go off to the store for data gathering by themselves, but by the third week, they had grasped the concept of skill-sharing, although they still found it difficult to get used to working with others. Pairs allocated tasks in a variety of ways: by working to their strengths, by working jointly on everything to cross fertilize knowledge, or in a few cases, by non co-operation. It was a steep learning curve and one where the students wished they had had more time, although we were very happy with what they had produced.

The final prototype models were made from a variety of materials, mostly compressed foam, ply, MDF, Perspex, wire and limited 3D printing. The iterative model process was invaluable, and one could see from the results, sketches and boards exactly where the design thinking had come from really clearly.

The potential prize was enough of an incentive to get even the most incompatible pairs working to a high level of output (all pairs presented to the client and most were highly praised for their efforts).

The client said: *"I was impressed by the variety and range of ideas/concepts. I thought the presentation material was very good and it was clear that a lot of effort went into the project*". It was a rigorous process.

3.2 Results Project 2

3.2.1 Integrated learning

Having been through a raft of creativity exercises for Project 1, we mistakenly assumed that students would incorporate and re-employ some of the techniques they had learned for Project 1 in Project 2, Assessment 1 but the methodology had not been integrated within only three weeks.

The meditation activity, however, designed to enhance creativity, and extra classes in how to structure and improve presentation boards, yielded very high standards of creativity, visualisation and presentation, noted by the client and tutors and reflected in the SQs.

Whilst the initial four ideas were not very strong at Assessment 1 for some pairs, the other areas of assessment such as brand identity, market competitors and market gaps were strong for most.

3.2.2 Developmental prototyping strategy

Students were extremely motivated by this project after the initial hiccoughs with idea generation. The strategy of not giving any marks for finished designs for Assessment 2 yielded the intended learning outcomes of working purely with process and iterative improvements and demonstrated a remarkable leap forward in design thinking through activity, general research and user experience research. They loved the project specification, had a deep bond with and respect for the client and thoroughly enjoyed the long process of tinkering in the workshops before final prototypes were made, rather than having lecture-based seminars.

Solutions ranged from two part cheese slicers and graters in one gadget to salad spinning and salad dressing in one gadget to inventive peelers that could be held in various ways and pizza slicers with multi-functions. Some gadgets were modified and developed from quite unwieldy shapes, refining the appearance and letting it be dictated by testing and user analysis – the old 'form follows function' adage.

3.2.3 Assessment outcomes and client feedback

Students were so motivated on the project that four out of eleven pairs of students made CAD animations of how to use their products in addition to the specified assessment requirements. These demonstrated their inventions even more clearly.

The client was delighted with the results and said that *'the standard of work was very high…… The students really cared about their final designs and in my opinion this is wholly down to the support and guidance of the teaching staff who were firm but fair with constructive criticism'* (letter from client to tutors) and said he would be *'delighted'* to work with us again. He was very pleased with the *'well executed products with detailed working prototypes'.* He awarded two first prizes due to the standards being so high.

The external assessors for the course also highly praised the high standards of work and the innovative processes and methodologies used.

Confidence was gained in presentation of concepts to clients through repeated use and many ingenious ideas came out of the exercise, so much so that five product outcomes went to second level

consideration by WMF, the top stainless steel company in Germany. The ideas were presented to WMF after the module finished as they involved complex blade production and allowed the students involved the chance to rebrand the same products for another company in terms of visual boards and materials, which was an additional and very useful exercise, carried out through extra class tuition for those involved.

Both BAs and BScs performed way beyond expectations with their final prototypes and design thinking, resulting in an overall increase of marks on almost every level from previous years. There were no student failures and many students gained a 2:1 or 1 for this project, with only a sprinkling of 2:2 and 3 grades on the national Undergraduate scale.

3.2.4 Student satisfaction rates for both projects.

The table below represents satisfaction rates from both projects combined (see Table 1). This table only represents the UMSQ.

Table 1: Statistical data from UMSQ (both Design Projects) comparing 2008 with 2009 as a %

		University Feedback 2008			University Feedback 2009			Change %		
	Question	positive	neutral	negative	positive	neutral	negative	positive	neutral	negative
1	My previous leaning was a good preparation for this module	69	23	8	77	14	5	8	-9	-3
2	The module learning outcomes were clearly expressed	**61**	31	0	**86**	9	0	**25**	-22	0
3	The taught sessions have helped me achieve the module learning outcomes	85	8	0	91	9	0	6	1	0
4	The taught sessions have been well structured	**77**	15	0	**91**	5	5	**14**	-10	5
5	The taught sessions have been intellectually stimulating	84	0	8	87	14	0	3	14	-8
6	I have been given the opportunity to participate actively in taught sessions	76	15	0	81	9	9	5	-6	9
7	I have had the opportunity to consult my tutor concerning my work	84	8	8	77	14	0	-7	6	-8
8	I have received helpful feedback on my work	100	0	0	86	5	5	-14	5	5
9	The assessment requirements have been easy to understand	**46**	54	0	**87**	9	5	**41**	-45	5
10	I feel that the assessment has allowed me to demonstrate that I have achieved	**69**	23	0	**86**	14	0	**17**	-9	0
11	I have found that the workload for this module has been manageable (i.e. it has	**39**	31	31	**77**	18	5	**38**	-13	-26
12	I have been able to access general IT resources	85	8	0	95	0	5	10	-8	5
13	There has been sufficient access to suitable specialised equipment	77	15	0	77	18	5	0	3	5
14	I have found that the rooms for teaching are suitable	**54**	31	16	**82**	9	9	**28**	-22	-7
15	The Library resources have been good enough for my needs	61	23	8	68	23	9	7	0	1
16	I have found that the e-learning component (OASISplus or other) of this	**46**	0	39	**59**	36	5	**13**	36	-34
17	The use of e-learning has provided increased opportunities for interacting	**54**	15	23	**68**	27	5	**14**	12	-18
18	The use of e-learning has enhanced my learning experience on this module	**46**	15	30	**59**	32	0	**13**	17	-30
19	Overall I am satisfied with the quality of this module	**62**	15	16	**86**	9	0	**24**	-6	-16

Columns that are shaded show significant gains using our methodology over the previous method of teaching students on single disciplines (BA and BSc) working alone on projects, especially reflected in questions **2, 9, 11** and **19** where the improvement rates jumped dramatically with a **25%** increase in understanding of the learning outcomes expected, a **41%** increase in understanding of the assessment requirements, a **38%** increase in perception of the manageability of the tasks and a **24%** increase in satisfaction with the quality of the module.

The only areas where satisfaction decreased were with feedback, (see questions 7 and 8). We subsequently discovered that this was because students wanted much more 1:1 time and less class feedback, **not because of the quality of our feedback** per se. In the SQ, 20 students out of 22 expressed very high levels of satisfaction by saying we had given them positive feedback, for example '*Very much so…..it was also very useful getting feedback from a tutor with a design background as well as one with an engineering background'* and used language like *'helpful' and 'useful'* (SQ)

The SQs, which acted as an additional indicator to the UMSQs and were tailored specifically to the module, elicited further important data, comments and module specific answers, notably a **91%** positive appreciation of the value of working in pairs, an **86.5**% recognition of the improvement in graphics and visualisation skills, a **77.2**% positive response about learning new CAD rendering techniques concurrently to the module, an **81.8**% positive response about the incentive of having a prize for the project, an **86.5**% positive response about the client's feedback on Project 2 and a

whopping **100%** satisfaction rate of working with the client on Project 2. (Some of the other percentages were neutral responses rather than all negative ones.)

4 DISCUSSION

The collaboration between BAs and BScs allowed far more technical solutions than we had expected from students at this level and there were many mechanisms in evidence that would otherwise not have been attempted had we been working solely with BAs. Similarly, the BScs could not have produced such comprehensive designerly mechanisms without the input of the Bas (concluded from previous experience). The UMSQs and SQs highlighted many increased areas of satisfaction with how the module had been taught compared year on year. We believe the indicators are sufficiently surprisingly positive to conclude that the synergistic methodology of teaching works.

Overall we lost almost nothing through mixing the two disciplines but gained overall on the learning outcomes, and the data supports this. In future, the SQs will be aligned with the UMSQs ratings multiple choices (strongly agree, agree, neutral, disagree, definitely disagree) in order to assess satisfaction rates more accurately in terms of percentages and we can then easily combine them with the UMSFs to gain module specific answers that are holistic.

From the SQs, students felt they had significantly improved their skills within the eleven weeks of the pairings BA/BSc and that our feedback and the client's feedback (particularly for Project 2) was really useful. (The feedback for Project 1 was a little disjointed as there were three people that commented on the work, some of them arriving in the middle of the assessment session, which unsettled some students. They appreciated the value of the exercise in pairing BAs and BScs.

The additional voluntary work done by students for Project 2 to make CAD animations was testimony to the level of engagement and was evidence of the *'intrinsic motivation'* (Schawlow 1982 cited by Amabile 1997) – *'the motivation to work on something because it is interesting, involving, exciting, satisfying or personally challenging'*.

Project 2 was generally regarded as *'as near a perfect project as you could get'* (SQ).

The assessment criteria at each stage were critical parts of the development process, and the 'constructive alignment' through the careful design of the module assessment points (Biggs 1996), especially assessment of the Developmental prototyping stage, Project 2, Assessment 2 was key, both in terms of its criteria and **the late stage of assessment** (Week 6 out of 8), **allowing a long period for developmental iterations before final prototyping.**

Industry-sponsored 'live' projects were successful and key to the student motivation of having their work seen by a 'real' designer, their perception being at the beginning that the client's opinion surpassed that of their tutors (both of whom incidentally work with industrial partners themselves) It was *'Refreshing to hear honest feedback and criticism from a practising and successful design company'* (SQ).

By the end of the module, this had changed to a more balanced view of our feedback and input in combination with the client's: *'[the best aspects were] External rewards. Prestigious live client. Exciting new company. Intensive and exciting work'* and *'Good feedback at every stage'*. (SQ)

Students were also highly motivated by the prize for each project, the negative being that by definition, one winner means all the rest do not win, which can be tough. This added a competitive edge which was both positive, in terms of spurring on the work, and negative for the reason stated. The focus will be far more on process for new ongoing projects and although we will work with live projects, there will be less emphasis on prizes.

4.1 Issues and Corrective Actions

In terms of issues, only a few students, on reflection, were not happy with the project outcome(s), especially on Project 1 where they did not know their partner well. This was because their partner was not on the same level as they were or did not contribute equally, so they had a potentially difficult adjustment to make, to align their goals and their expectations of each other.

*'For this project [Project 1] we did not work well as a pair, allocation of tasks didn't really happen as such. My pair pretty much took on all the roles and I was stuck doing 'bits' or prototyping. We did initially start by going through all that needed to be done and attempting to allocate tasks but this didn't hold up for too long.' (*SQ, example of a negative comment for Project 1*)*

By the end of the second project, however, this factor had improved significantly and many were able to find *'a shared understanding'* (Kleinsmann et al 2010).

*'I picked someone who I knew had skills I didn't and would be motivated to do this kind of project. Seeing the work of groups from 'B' helped me decide who I would like to work with. (*SQ, example of a positive comment for Project 2*)*

Most said the split of tasks was 50:50 for Project 2, so gained identical marks. A few inequalities with input were adjusted accordingly.

Students were engaged by the process in Project 1 but many did not find 'hanging solutions' to be an area of intense interest, demonstrating that the choice of project was paramount to their contrastingly long term level of interest for Project 2 (where they loved the brief).

The tutors moderated all marks for projects through peer assessment of their student counterpart's contribution, in order to honour each individual's true contribution to the pair and reward input fairly. Most, when questioned about the complementary nature of their partner's skills, said things like *'I did [appreciate the value of working in pairs] because it allowed us to maximise each others' skills and was useful in the generation of ideas'.*

With regards to expecting the lessons learned in Project 1 to be automatically integrated into Project 2, with hindsight, it takes more than three weeks to integrate and consolidate previous learning processes. Students have to be reminded and processes repeated for them to be fully integrated. By the end of the eleven weeks, all students felt they had learnt and integrated an enormous amount and the results backed this up, so with a longer time frame, it worked.

Also, through student feedback, we learned that students would have appreciated more 1:1 time on their projects rather than always peer group learning and this will be integrated into our new framework for the current academic year.

4.1.1 Learnings

Overall we achieved our goals of successful BA/BSc collaboration through skill sharing, cross fertilization, activity-based learning and, most importantly, the long period of functionality development before final prototyping.

4.1.2 Recommendations

We recommend the adoption of our methodology of combined learning skills for BAs and BScs because it worked synergistically, improving the levels of students in both disciplines, because it maintained high levels of interest and engagement from students and because it resulted in exciting new products that exceeded the learning outcomes for the Design Projects module.

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